JC10 Rec'd PCT/PTO 14 JUN 2001

FORM PTO-1390 (Modified) (REV 11-98)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER
112740-157

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR
09/868086

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE99/03851	01 December 1999	15 December 1998

TITLE OF INVENTION
METHOD FOR PROVIDING A STABLE QUALITY GRADE FOR DATA SERVICES WITHIN A PACKET-SWITCHING NETWORK

APPLICANT(S) FOR DO/EO/US
Christian Prehofer

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☒ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☒ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Submission of Drawings - Figure 1 on one sheet

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APPLICATION NO. (IF KNOWN, SEE 37 CFR	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/868086	PCT/DE99/03851	112740-157

21. The following fees are submitted:.

	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1,000.00**		
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO **$860.00**		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**		
☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**		
☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	7 - 20 =	0	x $18.00	**$0.00**	
Independent claims	1 - 3 =	0	x $80.00	**$0.00**	
Multiple Dependent Claims **(check if applicable).**			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$860.00**	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable).** ☐				**$0.00**	
SUBTOTAL =				**$860.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**	
TOTAL NATIONAL FEE =				**$860.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐				**$0.00**	
TOTAL FEES ENCLOSED =				**$860.00**	
				Amount to be: refunded	$
				charged	$

☒ A check in the amount of **$860.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees. A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **02-1818** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

William E. Vaughan (Reg. No. 39,056))
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SIGNATURE

William E. Vaughan
NAME

39, 056
REGISTRATION NUMBER

June 14, 2001
DATE

09/868086
JC18 Rec'd PCT/PTO 14 JUN 2001

BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANT:	Christian Prehofer	DOCKET NO: 112740-157
SERIAL NO:		GROUP ART UNIT:
		EXAMINER:
INTERNATIONAL APPLICATION NO:		PCT/DE99/03851
INTERNATIONAL FILING DATE:		01 December 1999
INVENTION:	METHOD FOR PROVIDING A STABLE QUALITY GRADE FOR DATA SERVICES WITHIN A PACKET-SWITCHING NETWORK	

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

Please amend the above-identified International Application before entry into the National stage before the U.S. Patent and Trademark Office under 35 U.S.C. §371 as follows:

In the Specification:

Please replace the Specification of the present application, including the Abstract, with the following Substitute Specification:

S P E C I F I C A T I O N

TITLE

METHOD FOR PROVIDING A STABLE QUALITY GRADE FOR DATA SERVICES WITHIN A PACKET-SWITCHING NETWORK

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates, generally, to a method for providing a stable quality grade for data services within a packet-switching network and, more specifically, to such a method wherein a quality grade of a transmission is compared with a quality grade demanded by a data service and, depending on a result of the comparison, data packets associated with the data service may be assigned to another quality class.

Description of the Prior Art

Say, for example, a subscriber would like to use data services in a packet-switching network; e.g., the Internet. Normally, the subscriber gains access to the packet-switching network by first using his/her subscriber terminal, or a personal computer, to dial into the packet-switching network either directly or indirectly via a private branch exchange or local exchange at an access node. The subscriber then sets up a connection to a network node providing data services in the packet-switching network, e.g. to a computer of a service provider, and requests data services from such a network node by, for example, using an application program available on his personal computer.

Corresponding conditions likewise apply to a private packet-switching network; e.g., to a company network. In this case, the access node to the private packet-switching network is usually integrated into the subscriber terminal or into the private branch exchange. Such a private packet-switching network can also have access to another private or public packet-switching network, such as to a company network or to the Internet. Accordingly, a network node providing data services may be situated not only in the public packet-switching network but also in a private packet-switching network.

In such a packet-switching network, such as the Internet, the data transmission is normally connectionless, i.e. the data packets having identical origin and destination addresses are transported independently of one another, so that neither the order nor delivery of the data packets at the destination node is guaranteed (OSI layer 3 protocol). It is, therefore, also not possible to assure a quality grade for the transmission of data packets between origin and destination

nodes, such as a certain bandwidth, delay times, a particular throughput and a low packet loss rate.

Video transmission services (e.g., Video on Demand) and various telephone services (e.g., Voice over IP), in particular, require secure and rapid data transmission on the Internet with an assured constant quality grade. Data services requested by a subscriber, such as Video on Demand, Voice over IP or videoconference circuits require secure and rapid data transmission with an assured and, at the same time, stable quality grade.

With respect to the Internet, an approach is currently being discussed within the sphere of the concept of "Differentiated Services", which guarantees the demanded bandwidth and shorter delay times for transmission of the data packets associated with such data services.

By way of example, an 'Internet draft' document "Differentiated Services Model and Definitions" written by K. Nichols and S. Blake, published by the Internet Engineering Task Force in February 1998 (Internet page: http://www.ietf.org/internet-draft/draft-nichols-dsopdef-00.txt) proposes a method which permits accelerated transmission of data packets from an origin node to a destination node. For data packets associated with a data service which demands a high transmission bandwidth, particular bits of the 'TOS byte' are respectively set in the header part of such data packets. On the basis of the bits which have been set in the TOS byte, the data packets are assigned to different quality classes. Depending on the assigned quality class, the data packets are possibly given preferential treatment in the intermediate nodes. As such, accelerated forwarding, that is to say virtually without delay, to the next intermediate or network node is attempted. An example of a quality class with low priority is the "Best Effort" class customary on the Internet. According to this, the data packets are handled as soon as possible, and as many as possible from one data service are handled. An example of a quality class having very high priority is the "Premium" class, which is distinguished by extremely short delay times and is, therefore, more or less comparable to a virtual connection.

Additional comments relating to the method explained above can be found in other Internet draft documents "An Architecture for Differentiated Services", written by D. Blake, S. Blake, M. Carlson, E. Davies, Zh. Wang, W. Weiss, published by the Internet Engineering Task Force in May 1998 (Internet page: http://www.ietf.org/internet-draft/draft-ietf-diffserv-arch-00.txt) and "A Framework for Differentiated Services", written by Y. Bernet, J. Binder, S. Blake, M. Carlson, S. Keshav, E. Davies, B. Ohlman, D. Verma, Zh. Wang, W. Weiss, published by the Internet Engineering Task Force in October 1998 (Internet page: http://www.ietf.org/internet-draft/draft-ietf-diffserv-framework-01.txt).

A significant disadvantage of the method outlined above is that preferential treatment permits data services whose data packets have been assigned to a particular quality class to be assured only of a quality grade which is dependent on the network utilization level.

This problem becomes particularly evident if a large number of data services are requested by subscribers who require a constant or stable and, at the same time, high quality grade for the delay and the transmission bandwidth. In this case, it is no longer possible to provide each data service with the demanded quality grade.

A quite different approach, which has its origin in conjunction with multimedia applications in ATM networks (Asynchronous Transfer Mode), in which virtual connections are set up in a known manner between subscribers and the network nodes providing data services, is to match the transmission bandwidth of multimedia applications to the network utilization level.

For transmission to connectionless packet-switching networks, a publication by I. Busse, B. Deffner and H. Schulzrinne entitled "Dynamic QoS Control of Multimedia Applications based on RTP", First International Workshop on High Speed Networks and Open Distributed Platforms, St. Petersburg (Russia), June 1995 presents a method in which, for multimedia applications, the transmitter matches the transmission bandwidth dynamically on the basis of the transmission quality obtained at the receiver. In particular, the transmission bandwidth is reduced

if, with a high network utilization level, a high packet loss rate at the receiver has been reported to the transmitter. To this end, the 'RTP/RTCP' protocol is used, which delivers to the transmitter an acknowledgement about the transmission quality obtained at the receiver.

A significant disadvantage of this method is, accordingly, that such data services cannot be assured of a stable transmission quality for a high network utilization level. Instead of guaranteeing a constant or stable transmission bandwidth, the transmission bandwidth is more readily reduced for a high network utilization level. As such, the data service is received with poor quality. This can even result in data transmission needing to be terminated on account of the quality being too poor for the data service.

An object of the present invention is to develop a method such that, when a requested data service is transmitted, the stable quality grade demanded by the data service is provided.

SUMMARY OF THE INVENTION

According to the present invention, therefore, a stable quality grade for such data services is provided by virtue of the fact that, during the transmission of data packets which are associated with such a data service and are assigned to a quality class with the aim of possible preferential treatment, these data packets are possibly assigned to another quality class, which is expected to provide the quality grade demanded by the data service, on the basis of a result of a comparison between an acknowledged quality grade which actually exists in the packet-switching network and the demanded quality grade. In other words: the transmitter or at least one intermediate node in the packet-switching network establishes the quality of the transmission on the basis of acknowledgements which indicate the quality grade and compares the acknowledged quality grade with the quality grade demanded by the data service.

If the acknowledged quality grade is below the demanded quality grade, the transmitter or an intermediate node will assign the data packets associated with the data service to a higher quality class, of which the quality grade demanded by the

data service is expected. If the acknowledged quality grade has virtually the same or a higher value than the quality grade demanded by the data service, then the transmitter or the intermediate node possibly assigns the data packets associated with the data service to a low quality class, if the expectation of a constant quality grade is high. Otherwise, the quality class assigned at the start of data transmission is retained.

As a result, particularly at a high utilization level, the dynamic matching of the quality class on the basis of the network conditions prevents the quality grade from dropping during data transmission, and hence keeps the quality grade stable. In addition, the method according to the present invention allows resource consumption in the packet-switching network to be controlled.

One embodiment of the present invention affords, in addition to the various quality classes, a number of priority classes within a quality class. Accordingly, the data packets associated with a data service are first assigned to another priority class within a quality class before they are assigned to another quality class. This provides an additional option for correcting the acknowledged quality grade to the quality grade demanded by the data service, without needing to change the quality class.

In accordance with one advantageous embodiment of the present invention, during a change to another quality class, the data packets associated with a data service are first assigned to the lowest priority class within the newly assigned quality class. This makes it possible to prevent the transmission of data packets assigned to the other quality class from being impaired as a result of the change.

Another embodiment of the present invention provides that, for the comparison between the acknowledged quality grade and the quality grade demanded by the data service, at least one upper threshold value and at least one lower threshold value are introduced. Thus, if at least one upper threshold value is exceeded by the difference between the demanded quality grade and the acknowledged quality grade, this results in the data packets associated with the data service being assigned to a higher quality class or possibly to a higher priority class.

If at least one lower threshold value is undershot by the difference between the demanded quality grade and the acknowledged quality grade, the data packets are assigned to a low quality class or possibly to a low priority class. This has the advantage of additional stabilization of the quality grade during data transmission owing to the fact that a constant change between the quality classes or the priority classes is avoided.

Another advantageous embodiment of the present invention uses not only the quality of the transmission of such data packets but also a further comparison parameter; namely, the network utilization level. If the acknowledged quality grade and the quality grade demanded by the data service have virtually the same valve, the assignment of the data packets associated with the data service to a quality class is additionally dependent on the network utilization level. With a high network utilization level, the data packets are more readily assigned to a high quality class or possibly to a high priority class, and with a low network utilization level, these data packets are more readily assigned to a low quality class or possibly to a low priority class. The additional comparison parameter increases the likelihood of the quality grade which is to be expected being reached or at least retained when the quality class changes.

Another embodiment of the present invention relates to an advantageous implementation with respect to the handling, on the basis of the associated quality class, of such data packets in an intermediate node. Before such data packets are forwarded, they are temporarily stored in a queue which is based on their quality class.

In accordance with another embodiment of the present invention, the priority classes possibly available in a quality class are advantageously implemented such that the data packets arriving at an intermediate node and associated with a data service are temporarily stored in a queue before being forwarded and are characterized using a marker which is based on their priority class and can be used to discard the characterized data packets if the queue overflows.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Preferred Embodiments and the Drawings.

DESCRIPTION OF THE DRAWINGS

Figure 1 shows a packet-switching network to which the method according to the present invention can be applied.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Fig. 1, a subscriber terminal TLN is connected to the packet-switching network PN, e.g. the Internet, via an access node ZK. The indicated packet-switching network PN also could be a private packet-switching network, e.g. a company network. In the case of a private packet-switching network, the access node ZK is usually integrated into the subscriber terminal or into the private branch exchange. Such a private packet-switching network can also have a point of access to another private or public packet-switching network; e.g., to a company network or to the Internet. The packet-switching network PN in Fig. 1 can then be regarded as a communication network comprising all the private and public packet-switching networks.

Fig. 1 also shows a computer DK, e.g. of a service provider, which provides subscribers with data services, such as Video on Demand or Voice over IP, and is situated in the packet-switching network PN. The intermediate nodes ZW1 to ZW4 connected in between the computer DK and the access node ZK indicate that there can be a number of connection options between the computer DK and the access node ZK. Thus, on the Internet, for example, as already mentioned in the introduction, it is customary for data packets to get to their destination independently of one another on different paths.

In the example, a subscriber uses his/her subscriber terminal TLN, e.g. a personal computer, to dial into the packet-switching network PN via the connection to the access node ZK, and uses an application program provided on his subscriber terminal to set up a connection to a computer DK, providing data services, of a service provider, e.g. via the intermediate nodes ZW1 to ZW4. The subscriber

requests a video transmission service, for example, which requires a transmission bandwidth of 100 kbit/s. Accordingly, the data packets associated with the video transmission service are assigned to a mean quality class, for example, by setting a particular bit pattern in the 'TOS byte' of such a data packet. Assuming that there are quality classes of A (e.g. premium), B (e.g. normal) and C (e.g. best effort), with A distinguishing the highest class, then the data packets associated with the video transmission service are assigned to the class B in the example.

Ideally, the quality classes are subdivided further into priority classes, e.g. 1 (low) to 8 (high). By way of example, the data packets associated with the video transmission service are assigned to the priority class 4, with the priority class likewise being able to be characterized in the 'TOS byte' of such data packets.

At the start of transmission of the video transmission service, the data packets are thus sent with the quality class B and the priority class 4. During transmission, an intermediate node, e.g. ZW1, or the receiver, e.g. ZK or TLN, acknowledges to the transmitter, in the example the computer of a service provider DK, the quality grade, such as the bandwidth, delay times to the network node and the packet loss rate for the transmission, using a protocol, e.g. the RTP/RTCP protocol mentioned in the introduction, and then compares the acknowledged quality grade with the demanded quality grade. Preferably, at least one upper limit and at least one lower limit are stipulated for the comparison. If the limits are exceeded or undershot by the difference between the demanded quality grade (NOMINAL value) and the acknowledged quality grade (ACTUAL value), for example for the transmission bandwidth, a change to another quality class or possibly priority class is triggered. In this case, the ACTUAL value can be determined, by way of example, by the average value with, if appropriate, a stipulated permissible discrepancy (e.g., +/- 5%) from quality grade values acknowledged cyclically over a particular period of time (e.g., 1 second). Accordingly, the levels for the difference between the NOMINAL value and the ACTUAL value can be set as triggers for a change to a higher/lower quality class or priority class such that, by way of example, the following rules are produced:

1. If a positive difference between NOMINAL and ACTUAL value has a value of more than 128 kbit/s, then a change to the highest quality class A is made.
2. A corresponding negative difference of less than -128 kbit/s triggers a change to the lowest quality class C.
3. With a positive difference of more than 64 kbit/s, there is a change to the next highest quality class.
4. With a corresponding negative difference of less than -64 kbit/s, there is a change to the next lowest quality class.
5. If the positive difference constitutes less than 64 kbit/s, or the negative difference constitutes more than -64 kbit/s, then the quality class is retained.
6. A positive or negative difference of more than 8 kbit/s or less than -8 kbit/s results in a change to the next highest or lowest priority class (max. 8 priority classes).

Similar rules can be stipulated for other quality grade features than for the transmission bandwidth, such as for the delay time, the packet loss rate and the throughput. Particularly with a voice data service such as Voice over IP, the transmission bandwidth would be less of a crucial factor for a change of quality class than the delay time and possibly the packet loss rate.

By way of example, a transmission bandwidth of 76 kbit/s obtained at the receiver, e.g. TLN, is acknowledged to the transmitter, e.g. DK, instead of the demanded transmission bandwidth of 100 kbit/s. The transmitter then rearranges the data packets associated with the video transmission service from the priority class 4 into the priority class 5; for example, on the basis of the rules 5 and 6 indicated above. If the transmission bandwidth of 100 kbit/s is now detected, the priority class can be retained. Otherwise, reassignment to a higher priority class is repeated until the demanded transmission bandwidth is reached. Under the circumstance in which the highest priority class in the quality class has already been assigned and only a transmission bandwidth of, by way of example, 85 kbit/s

could be achieved, it is appropriate to assign the data packets associated with the video transmission service to the next highest quality class, e.g. A. Preferably, these data packets in the next highest quality class are then first assigned to the lowest priority class, e.g. 1, so as not to impair the quality of the transmission of data packets associated with other data services within this quality class. If the influence on the transmission quality is too great, the data packets associated with the video transmission service can, if appropriate, be removed from this quality class and assigned to the original quality class again.

Advantageously, the network utilization level can also be used to determine the quality or priority class. Thus, in addition to the transmission bandwidth obtained at the receiver, the delay times or fluctuations in the delays can also be acknowledged. Accordingly, after repeated assignment to a higher priority class and with a subsequently acknowledged short delay time, it would be possible to try to assign the data packets associated with the video transmission service to a lower priority class or possibly to a lower quality class again. In the case of a long delay time, which indicates a high network utilization level, the data packets associated with the video transmission service are more readily assigned to even higher priority classes or are predominantly assigned to a higher quality class. In addition, the data packets associated with other data services in the packet-switching network could be prevented from changing to a higher priority class or quality class.

Expediently, the quality classes are implemented in the form of separate queues in the network nodes (intermediate nodes, e.g. ZW1 to ZW4) of the packet-switching network. The data packets arriving at the intermediate nodes are temporarily stored in a queue which is based on their quality class before being forwarded. The priority classes are usefully produced by a 'drop level' mechanism. That is, the data packets arriving at an intermediate node are provided with a marker which is based on their priority class and are temporarily stored in a queue which is based on their quality class. If the queue overflows, the data packets associated with a low priority class are discarded first.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

ABSTRACT OF THE DISCLOSURE

In a packet-switching network, a stable quality grade is achieved for data services by virtue of the fact that, during the transmission of data packets which are associated with a data service and are assigned to a quality class for the purposes of possible preferential treatment, the transmitter, generally a computer of a service provider, and/or at least one intermediate node establishes the quality of the transmission on the basis of acknowledgements indicating the quality grade and compares it with the quality grade demanded by the data service, and, on the basis of the result of the comparison, the data packets associated with the data service are possibly assigned to another quality class, of which the quality grade demanded by the data service is expected.

In the claims:

On page 13, cancel line 1, and substitute the following left-hand justified heading therefor:

I Claim as My Invention:

Please cancel claims 1-7, without prejudice, and substitute the following claims therefor:

8. A method for providing a stable quality grade for data services within a packet-switching network which has at least one access node for connecting at least one of at least one subscriber terminal and at least one private branch exchange having at least one connected subscriber terminal, and has at least one of a plurality of network nodes for providing data services, the method comprising the steps of:

assigning data packets,, which are respectively associated with the data service, at a start of transmission between the at least one network node providing the data service and one of a subscriber terminal and an access node connected to a

subscriber terminal, to a quality class whereupon the data packets are handled within intermediate nodes which forward the data packets;

establishing, via at least one of the at least one network node and at least one intermediate node, and during transmission of the data packets, a quality of the transmission based on acknowledgements indicating a quality grade, and comparing the quality of the transmission with a quality grade demanded by the data service; and

assigning the data packets associated with the data service, depending on a result of the comparison, to another quality class of which the quality grade demanded by the data service is expected.

9. A method for providing a stable quality grade for data services within a packet-switching network as claimed in claim 8, wherein a quality class includes a plurality of subordinate priority classes, and the data packets associated with the data service are first assigned to another priority class within a quality class before assignment to another quality class occurs.

10. A method for providing a stable quality grade for data services within a packet-switching network as claimed in claim 9, wherein, if the data packets associated with the data service are assigned to another quality class, the data packets are first assigned to a lowest priority class.

11. A method for providing a stable quality grade for data services within a packet-switching network as claimed in claim 9, wherein at least one upper and at least one lower threshold value is stipulated for the comparison between the acknowledged quality grade and the quality grade demanded by the data service and, if the at least one upper threshold value is exceeded by the difference between the demanded quality grade and the acknowledged quality grade, the data packets associated with the data service are assigned to one of a higher quality class and a higher priority class and, if the at least one lower threshold value is undershot by

the difference between the demanded quality grade and the acknowledged quality grade, the data packets are assigned to one of a low quality class and a low priority class.

12. A method for providing a stable quality grade for data services within a packet-switching network as claimed in claim 9, wherein, besides the quality of the transmission of the data packets, a network utilization level is also acknowledged and, if the acknowledged quality grade and the quality grade demanded by the data service have a substantially same value and the network utilization level is high, the data packets are preferably assigned to one of a high quality class and a high priority class and, if the acknowledged quality grade and the quality grade demanded by the data service have a substantially same value and the network utilization level is low, the data packets are preferably assigned to one of a low quality class and a low priority class.

13. A method for providing a stable quality grade for data services within a packet-switching network as claimed in claim 9, wherein the data packets arriving at an intermediate node and associated with the data service are temporarily stored in a queue, which is based on the quality class of the data packets, before the data packets are forwarded.

14. A method for providing a stable quality grade for data services within a packet-switching network as claimed in claim 9, wherein the data packets arriving at an intermediate node and associated with the data service are temporarily stored in a queue before being forwarded and are characterized using a marker which is based on a priority class of the data packets and which can be used to discard the characterized data packets if the queue overflows.

REMARKS

The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the

specification to the requirements of United States Patent Practice. No new matter is added thereby. Attached hereto is a marked-up version of the changes made to the specification by the present amendment. The attached page is captioned "**Version With Markings To Show Changes Made".**

In addition, the present amendment cancels original claims 1-7 in favor of new claims 8-14. Claims 8-14 have been presented solely because the revisions by red-lining and underlining which would have been necessary in claims 1-7 in order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 USC §§103, 102, 103 or 112. Indeed, the cancellation of claims 1-7 does not constitute an intent on the part of the Applicants to surrender any of the subject matter of claims 1-7.

Early consideration on the merits is respectfully requested.

Respectfully submitted,

(Reg. No. 39,056)

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VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

In The Specification:

The Specification of the present application, including the Abstract, has been amended as follows:

SPECIFICATION

TITLE

~~**Method for providing a stable quality grade for data services within a packet-switching network**~~

METHOD FOR PROVIDING A STABLE QUALITY GRADE FOR DATA SERVICES WITHIN A PACKET-SWITCHING NETWORK

BACKGROUND OF THE INVENTION

~~Description~~

Field of the Invention

~~The invention relates to a method for providing a stable quality grade for data services within a packet-switching network in accordance with the precharacterizing clause of patent claim 1.~~

The present invention relates, generally, to a method for providing a stable quality grade for data services within a packet-switching network and, more specifically, to such a method wherein a quality grade of a transmission is compared with a quality grade demanded by a data service and, depending on a result of the comparison, data packets associated with the data service may be assigned to another quality class.

Description of the Prior Art

~~Accordingly, by way of example,~~ Say, for example, a subscriber would like to use data services in a packet-switching network~~,~~; e.g., the Internet. Normally, the subscriber gains access to the packet-switching network by first using his/her subscriber terminal, ~~e.g.~~ or a personal computer, to dial into the packet-switching network either directly or indirectly via a private branch exchange or local exchange at an access node~~,~~. ~~and setting~~ The subscriber then sets up a connection to a network node providing data services in the packet-switching network, e.g. to a

computer of a service provider, and ~~requesting~~ requests data services from such a network node by, ~~e.g.~~ for example, using an application program available on his personal computer.

Corresponding conditions likewise apply to a private packet-switching network~~,~~; e.g., to a company network. In this case, the access node to the private packet-switching network is usually integrated into the subscriber terminal or into the private branch exchange. Such a private packet-switching network can also have access to another private or public packet-switching network, ~~e.g.~~ such as to a company network or to the Internet. Accordingly, a network node providing data services may be situated not only in the public packet-switching network but also in a private packet-switching network.

In such a packet-switching network, such as the Internet, the data transmission is normally connectionless, i.e. the data packets having identical origin and destination addresses are transported independently of one another, so that neither the order nor delivery of the data packets at the destination node is guaranteed (OSI layer 3 protocol). It is, therefore, also not possible to assure a quality grade for the transmission of data packets between origin and destination nodes, such as a certain bandwidth, delay times, a particular throughput and a low packet loss rate.

Video transmission services (e.g., Video on Demand) and various telephone services (e.g., Voice over IP), in particular, require secure and rapid data transmission on the Internet with an assured constant quality grade. Data services requested by a subscriber, such as Video on Demand, Voice over IP or videoconference circuits require secure and rapid data transmission with an assured and, at the same time, stable quality grade.

With respect to the Internet, an approach is currently being discussed within the sphere of the concept of "Differentiated Services", which guarantees the demanded bandwidth and shorter delay times for transmission of the data packets associated with such data services.

By way of example, an 'Internet draft' document "Differentiated Services Model and Definitions" written by K. Nichols and S. Blake, published by the Internet Engineering Task Force in February 1998 (Internet page: http://www.ietf.org/internet-draft/draft-nichols-dsopdef-00.txt) proposes a method which permits accelerated transmission of data packets from an origin node to a destination node. For data packets associated with a data service which demands a high transmission bandwidth, particular bits of the 'TOS byte' are respectively set in the header part of such data packets. On the basis of the bits which have been set in the TOS byte, the data packets are assigned to different quality classes. Depending on the assigned quality class, the data packets are possibly given preferential treatment in the intermediate nodes~~,~~. ~~which means, above all, that~~ As such, accelerated forwarding, that is to say virtually without delay, to the next intermediate or network node is attempted. An example of a quality class with low priority is the "Best Effort" class customary on the Internet. According to this, the data packets are handled as soon as possible, and as many as possible from one data service are handled. An example ~~which may be mentioned~~ of a quality class having very high priority is the "Premium" class, which is distinguished by extremely short delay times and is, therefore, more or less comparable to a virtual connection.

Additional comments relating to the method explained above can be found in other Internet draft documents "An Architecture for Differentiated Services", written by D. Blake, S. Blake, M. Carlson, E. Davies, Zh. Wang, W. Weiss, published by the Internet Engineering Task Force in May 1998 (Internet page: http://www.ietf.org/internet-draft/draft-ietf-diffserv-arch-00.txt) and "A Framework for Differentiated Services", written by Y. Bernet, J. Binder, S. Blake, M. Carlson, S. Keshav, E. Davies, B. Ohlman, D. Verma, Zh. Wang, W. Weiss, published by the Internet Engineering Task Force in October 1998 (Internet page: http://www.ietf.org/internet-draft/draft-ietf-diffserv-framework-01.txt).

A significant disadvantage of the method outlined above is that preferential treatment permits data services whose data packets have been assigned to a

particular quality class to be assured only of a quality grade which is dependent on the network utilization level.

This problem becomes particularly evident if a large number of data services are requested by subscribers who require a constant or stable and, at the same time, high quality grade for the delay and the transmission bandwidth. In this case, it is no longer possible to provide each data service with the demanded quality grade.

A quite different approach, which has its origin in conjunction with multimedia applications in ATM networks (Asynchronous Transfer Mode), in which virtual connections are set up in a known manner between subscribers and the network nodes providing data services, is to match the transmission bandwidth of multimedia applications to the network utilization level.

For transmission to connectionless packet-switching networks, a publication by I. Busse, B. Deffner and H. Schulzrinne entitled "Dynamic QoS Control of Multimedia Applications based on RTP", First International Workshop on High Speed Networks and Open Distributed Platforms, St. Petersburg (Russia), June 1995 presents a method in which, for multimedia applications, the transmitter matches the transmission bandwidth dynamically on the basis of the transmission quality obtained at the receiver. In particular, the transmission bandwidth is reduced if, with a high network utilization level, a high packet loss rate at the receiver has been reported to the transmitter. To this end, the 'RTP/RTCP' protocol is used, which delivers to the transmitter an acknowledgement about the transmission quality obtained at the receiver.

A significant disadvantage of this method is, accordingly, that such data services cannot be assured of a stable transmission quality for a high network utilization level. Instead of guaranteeing a constant or stable transmission bandwidth, the transmission bandwidth is more readily reduced for a high network utilization level. ~~This means that~~ As such, the data service is received with poor quality. This can even result in data transmission needing to be terminated on account of the quality being too poor for the data service.

~~The~~ An object of the present invention is to develop a method ~~of the type specified in the precharacterizing clause of patent claim 1~~ such that, when a requested data service is transmitted, the stable quality grade demanded by the data service is provided.

~~This object is achieved by the features specified in the characterizing part of claim 1. Other refinements of the invention are characterized in dependent claims.~~

SUMMARY OF THE INVENTION

According to the present invention, therefore, a stable quality grade for such data services is provided by virtue of the fact that, during the transmission of data packets which are associated with such a data service and are assigned to a quality class with the aim of possible preferential treatment, these data packets are possibly assigned to another quality class, which is expected to provide the quality grade demanded by the data service, on the basis of a result of a comparison between an acknowledged quality grade which actually exists in the packet-switching network and the demanded quality grade. In other words: the transmitter or at least one intermediate node in the packet-switching network establishes the quality of the transmission on the basis of acknowledgements which indicate the quality grade and compares the acknowledged quality grade with the quality grade demanded by the data service.

If the acknowledged quality grade is below the demanded quality grade, the transmitter or an intermediate node will assign the data packets associated with the data service to a higher quality class, of which the quality grade demanded by the data service is expected. If the acknowledged quality grade has virtually the same or a higher value than the quality grade demanded by the data service, then the transmitter or the intermediate node possibly assigns the data packets associated with the data service to a low quality class, if the expectation of a constant quality grade is high. Otherwise, the quality class assigned at the start of data transmission is retained.

~~This means that~~ As a result, particularly at a high utilization level, the dynamic matching of the quality class on the basis of the network conditions

prevents the quality grade from dropping during data transmission, and hence keeps the quality grade stable. In addition, the method according to the present invention allows resource consumption in the packet-switching network to be controlled.

One ~~development~~ embodiment of the present invention affords, in addition to the various quality classes, a ~~plurality~~ number of priority classes within a quality class. Accordingly, the data packets associated with a data service are first assigned to another priority class within a quality class before they are assigned to another quality class. This provides an additional option for correcting the acknowledged quality grade to the quality grade demanded by the data service, without needing to change the quality class.

In accordance with one advantageous ~~refinement~~ embodiment of the present invention, during a change to another quality class, the data packets associated with a data service are first assigned to the lowest priority class within the newly assigned quality class. This makes it possible to prevent the transmission of data packets assigned to the other quality class from being impaired as a result of the change.

Another ~~refinement~~ embodiment of the present invention provides that, for the comparison between the acknowledged quality grade and the quality grade demanded by the data service, at least one upper threshold value and at least one lower threshold value are introduced. Thus, if at least one upper threshold value is exceeded by the difference between the demanded quality grade and the acknowledged quality grade, this results in the data packets associated with the data service being assigned to a higher quality class or possibly to a higher priority class. If at least one lower threshold value is undershot by the difference between the demanded quality grade and the acknowledged quality grade, the data packets are assigned to a low quality class or possibly to a low priority class. This has the advantage of additional stabilization of the quality grade during data transmission owing to the fact that a constant change between the quality classes or the priority classes is avoided.

Another advantageous ~~refinement~~ embodiment of the present invention uses not only the quality of the transmission of such data packets but also a further comparison parameter~~,~~; namely, the network utilization level. If the acknowledged quality grade and the quality grade demanded by the data service have virtually the same valve, the assignment of the data packets associated with the data service to a quality class is additionally dependent on the network utilization level. With a high network utilization level, the data packets are more readily assigned to a high quality class or possibly to a high priority class, and with a low network utilization level, these data packets are more readily assigned to a low quality class or possibly to a low priority class. The additional comparison parameter increases the likelihood of the quality grade which is to be expected being reached or at least retained when the quality class changes.

~~One development~~ Another embodiment of the present invention relates to an advantageous implementation with respect to the handling, on the basis of the associated quality class, of such data packets in an intermediate node. Before such data packets are forwarded, they are temporarily stored in a queue which is based on their quality class.

In accordance with another ~~refinement~~ embodiment of the present invention, the priority classes possibly available in a quality class are advantageously implemented such that the data packets arriving at an intermediate node and associated with a data service are temporarily stored in a queue before being forwarded and are characterized using a marker which is based on their priority class and can be used to discard the characterized data packets if the queue overflows.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Preferred Embodiments and the Drawings.

~~An illustrative embodiment of the invention is described in more detail below with reference to a drawing.~~

DESCRIPTION OF THE DRAWINGS

~~The figure~~ Figure 1 shows a packet-switching network to which the method according to the present invention can be applied.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

~~According to this~~ Referring to Fig. 1, a subscriber terminal TLN is connected to the packet-switching network PN, e.g. the Internet, via an access node ZK. The indicated packet-switching network PN also could ~~likewise~~ be a private packet-switching network, e.g. a company network. In the case of a private packet-switching network, the access node ZK is usually integrated into the subscriber terminal or into the private branch exchange. Such a private packet-switching network can also have a point of access to another private or public packet-switching network~~,~~; e.g., to a company network or to the Internet. The packet-switching network PN in ~~the figure~~ Fig. 1 can then be regarded as a communication network comprising all the private and public packet-switching networks.

~~The figure~~ Fig. 1 also shows a computer DK, e.g. of a service provider, which provides subscribers with data services, such as Video on Demand or Voice over IP, and is situated in the packet-switching network PN. The intermediate nodes ZW1 to ZW4 connected in between the computer DK and the access node ZK ~~in the figure~~ indicate that there can be a ~~plurality~~ number of connection options between the computer DK and the access node ZK. Thus, on the Internet, for example, as already mentioned in the introduction, it is customary for data packets to get to their destination independently of one another on different paths.

In the example, a subscriber uses his subscriber terminal TLN, e.g. a personal computer, to dial into the packet-switching network PN via the connection to the access node ZK, and uses an application program provided on his/her subscriber terminal to set up a connection to a computer DK, providing data services, of a service provider, e.g. via the intermediate nodes ZW1 to ZW4. The subscriber requests a video transmission service, for example, which requires a transmission bandwidth of 100 kbit/s. Accordingly, the data packets associated with the video transmission service are assigned to a mean quality class, for example, by setting a particular bit pattern in the 'TOS byte' of such a data packet. Assuming

that there are quality classes of A (e.g. premium), B (e.g. normal) and C (e.g. best effort), with A distinguishing the highest class, then the data packets associated with the video transmission service are assigned to the class B in the example.

Ideally, the quality classes are subdivided further into priority classes, e.g. 1 (low) to 8 (high). By way of example, the data packets associated with the video transmission service are assigned to the priority class 4, with the priority class likewise being able to be characterized in the 'TOS byte' of such data packets.

At the start of transmission of the video transmission service, the data packets are thus sent with the quality class B and the priority class 4. During transmission, an intermediate node, e.g. ZW1, or the receiver, e.g. ZK or TLN, acknowledges to the transmitter, in the example the computer of a service provider DK, the quality grade, such as the bandwidth, delay times to the network node and the packet loss rate for the transmission, using a protocol, e.g. the RTP/RTCP protocol mentioned in the introduction, and then ~~[lacuna]~~ compares the acknowledged quality grade with the demanded quality grade. ~~Expediently~~ Preferably, at least one upper limit and at least one lower limit are stipulated for the comparison~~,~~. ~~and if said~~ If the limits are exceeded or undershot by the difference between the demanded quality grade (NOMINAL value) and the acknowledged quality grade (ACTUAL value), for example for the transmission bandwidth, a change to another quality class or possibly priority class is triggered. In this case, the ACTUAL value can be determined, by way of example, by the average value with, if appropriate, a stipulated permissible discrepancy (e.g., +/- 5%) from quality grade values acknowledged cyclically over a particular period of time (e.g., 1 second). Accordingly, the levels for the difference between the NOMINAL value and the ACTUAL value can be set as triggers for a change to a higher/lower quality class or priority class such that, by way of example, the following rules are produced:

1. If a positive difference between NOMINAL and ACTUAL value has a value of more than 128 kbit/s, then a change to the highest quality class A is made.

2. A corresponding negative difference of less than -128 kbit/s triggers a change to the lowest quality class C.

3. With a positive difference of more than 64 kbit/s, there is a change to the next highest quality class.

4. With a corresponding negative difference of less than -64 kbit/s, there is a change to the next lowest quality class.

5. If the positive difference constitutes less than 64 kbit/s, or the negative difference constitutes more than -64 kbit/s, then the quality class is retained.

6. A positive or negative difference of more than 8 kbit/s or less than -8 kbit/s results in a change to the next highest or lowest priority class (max. 8 priority classes).

Similar rules can ~~likewise~~ be stipulated for other quality grade features than for the transmission bandwidth, such as for the delay time, the packet loss rate and the throughput. Particularly with a voice data service such as Voice over IP, the transmission bandwidth would be less of a crucial factor for a change of quality class than the delay time and possibly the packet loss rate.

By way of example, a transmission bandwidth of 76 kbit/s obtained at the receiver, e.g. TLN, is acknowledged to the transmitter, e.g. DK, instead of the demanded transmission bandwidth of 100 kbit/s. The transmitter then rearranges the data packets associated with the video transmission service from the priority class 4 into the priority class 5~~,~~; for example, on the basis of the rules 5 and 6 indicated above. If the transmission bandwidth of 100 kbit/s is now detected, the priority class can be retained. Otherwise, reassignment to a higher priority class is repeated until the demanded transmission bandwidth is reached. Under the circumstance in which the highest priority class in the quality class has already been assigned and only a transmission bandwidth of, by way of example, 85 kbit/s could be achieved, it is appropriate to assign the data packets associated with the video transmission service to the next highest quality class, e.g. A. ~~Expediently~~ Preferably, these data packets in the next highest quality class are then first

assigned to the lowest priority class, e.g. 1, so as not to impair the quality of the transmission of data packets associated with other data services within this quality class. If the influence on the transmission quality is too great, the data packets associated with the video transmission service can, if appropriate, be removed from this quality class and assigned to the original quality class again.

Advantageously, the network utilization level can also be used to determine the quality or priority class. Thus, in addition to the transmission bandwidth obtained at the receiver, the delay times or fluctuations in the delays can also be acknowledged. Accordingly, after repeated assignment to a higher priority class and with a subsequently acknowledged short delay time, it would be possible to try to assign the data packets associated with the video transmission service to a lower priority class or possibly to a lower quality class again. In the case of a long delay time, which indicates a high network utilization level, the data packets associated with the video transmission service are more readily assigned to even higher priority classes or are predominantly assigned to a higher quality class. In addition, the data packets associated with other data services in the packet-switching network could be prevented from changing to a higher priority class or quality class.

Expediently, the quality classes are implemented in the form of separate queues in the network nodes (intermediate nodes, e.g. ZW1 to ZW4) of the packet-switching network. The data packets arriving at the intermediate nodes are temporarily stored in a queue which is based on their quality class before being forwarded. The priority classes are usefully produced by a 'drop level' mechanism. That is, ~~to say that~~ the data packets arriving at an intermediate node are provided with a marker which is based on their priority class and are temporarily stored in a queue which is based on their quality class. If the queue overflows, the data packets associated with a low priority class are discarded first.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

~~Abstract~~

ABSTRACT OF THE DISCLOSURE

~~Method for providing a stable quality grade for data services within a packet-switching network~~

In a packet-switching network ~~(PN)~~, a stable quality grade is achieved for data services by virtue of the fact that, during the transmission of data packets which are associated with a data service and are assigned to a quality class for the purposes of possible preferential treatment, the transmitter, generally a computer of a service provider ~~(DK)~~, and/or at least one intermediate node ~~(ZW1 to ZW4)~~ establishes the quality of the transmission on the basis of acknowledgements indicating the quality grade and compares it with the quality grade demanded by the data service, and, on the basis of the result of the comparison, the data packets associated with the data service are possibly assigned to another quality class, of which the quality grade demanded by the data service is expected.

~~Figure~~

09/868086
JC18 Rec'd PCT/PTO 14 JUN 2001

GR 98 P 5926

Description

Method for providing a stable quality grade for data services within a packet-switching network

The invention relates to a method for providing a stable quality grade for data services within a packet-switching network in accordance with the precharacterizing clause of patent claim 1.

Accordingly, by way of example, a subscriber would like to use data services in a packet-switching network, e.g. the Internet. Normally, the subscriber gains access to the packet-switching network by using his subscriber terminal, e.g. a personal computer, to dial into the packet-switching network either directly or indirectly via a private branch exchange or local exchange at an access node, and setting up a connection to a network node providing data services in the packet-switching network, e.g. to a computer of a service provider, and requesting data services from such a network node, e.g. using an application program available on his personal computer.

Corresponding conditions likewise apply to a private packet-switching network, e.g. to a company network. In this case, the access node to the private packet-switching network is usually integrated into the subscriber terminal or into the private branch exchange. Such a private packet-switching network can also have access to another private or public packet-switching network, e.g. to a company network or to the Internet. Accordingly, a network node providing data services may be situated not only in the public packet-switching network but also in a private packet-switching network.

In such a packet-switching network, such as the Internet, the data transmission is normally connectionless, i.e. the data packets having identical origin and destination addresses are transported independently of one another, so that neither the order nor delivery of the data packets at the destination node is guaranteed (OSI layer 3 protocol). It is therefore also not possible to assure a quality grade for the transmission of data packets between origin and destination nodes, such as a certain bandwidth, delay times, a particular throughput and a low packet loss rate.

Video transmission services (e.g. Video on Demand) and various telephone services (e.g. Voice over IP), in particular, require secure and rapid data transmission on the Internet with an assured constant quality grade. Data services requested by a subscriber, such as Video on Demand, Voice over IP or videoconference circuits require secure and rapid data transmission with an assured and at the same time stable quality grade.

With respect to the Internet, an approach is currently being discussed within the sphere of the concept of "Differentiated Services", which guarantees the demanded bandwidth and shorter delay times for transmission of the data packets associated with such data services.

By way of example, an 'Internet draft' document "Differentiated Services Model and Definitions" written by K. Nichols and S. Blake, published by the Internet Engineering Task Force in February 1998 (Internet page: http://www.ietf.org/internet-draft/draft-nichols-dsopdef-00.txt) proposes a method which permits accelerated transmission of data packets from an origin node to a destination node. For data packets associated with a data service which demands a high transmission bandwidth, particular bits of the 'TOS byte' are respectively

set in the header part of such data packets. On the basis of the bits which have been set in the TOS byte, the data packets are assigned to different quality classes. Depending on the assigned quality class, the data packets are possibly given preferential treatment in the intermediate nodes, which means, above all, that accelerated forwarding, that is to say virtually without delay, to the next intermediate or network node is attempted. An example of a quality class with low priority is the "Best Effort" class customary on the Internet. According to this, the data packets are handled as soon as possible, and as many as possible from one data service are handled. An example which may be mentioned of a quality class having very high priority is the "Premium" class, which is distinguished by extremely short delay times and is therefore more or less comparable to a virtual connection.

Additional comments relating to the method explained above can be found in other Internet draft documents "An Architecture for Differentiated Services", written by D. Blake, S. Blake, M. Carlson, E. Davies, Zh. Wang, W. Weiss, published by the Internet Engineering Task Force in May 1998 (Internet page: http://www.ietf.org/internet-draft/draft-ietf-diffserv-arch-00.txt) and "A Framework for Differentiated Services", written by Y. Bernet, J. Binder, S. Blake, M. Carlson, S. Keshav, E. Davies, B. Ohlman, D. Verma, Zh. Wang, W. Weiss, published by the Internet Engineering Task Force in October 1998 (Internet page: http://www.ietf.org/internet-draft/draft-ietf-diffserv-framework-01.txt).

A significant disadvantage of the method outlined above is that preferential treatment permits data services whose data packets have been assigned to a particular quality class to be assured only of a quality grade which is dependent on the network utilization level.

This problem becomes particularly evident if a large number of data services are requested by subscribers who require a constant or stable and at the same time high quality grade for the delay and the transmission bandwidth. In this case, it is no longer possible to provide each data service with the demanded quality grade.

A quite different approach, which has its origin in conjunction with multimedia applications in ATM networks (Asynchronous Transfer Mode), in which virtual connections are set up in a known manner between subscribers and the network nodes providing data services, is to match the transmission bandwidth of multimedia applications to the network utilization level.

For transmission to connectionless packet-switching networks, a publication by I. Busse, B. Deffner and H. Schulzrinne entitled "Dynamic QoS Control of Multimedia Applications based on RTP", First International Workshop on High Speed Networks and Open Distributed Platforms, St. Petersburg (Russia), June 1995 presents a method in which, for multimedia applications, the transmitter matches the transmission bandwidth dynamically on the basis of the transmission quality obtained at the receiver. In particular, the transmission bandwidth is reduced if, with a high network utilization level, a high packet loss rate at the receiver has been reported to the transmitter. To this end, the 'RTP/RTCP' protocol is used, which delivers to the transmitter an acknowledgement about the transmission quality obtained at the receiver.

A significant disadvantage of this method is, accordingly, that such data services cannot be assured of a stable transmission quality for a high network utilization level. Instead of guaranteeing a constant or stable transmission bandwidth, the transmission bandwidth is more readily reduced for a high network utilization level. This means that the data service is

received with poor quality. This

can even result in data transmission needing to be terminated on account of the quality being too poor for the data service.

The object of the invention is to develop a method of the type specified in the precharacterizing clause of patent claim 1 such that, when a requested data service is transmitted, the stable quality grade demanded by the data service is provided.

This object is achieved by the features specified in the characterizing part of claim 1. Other refinements of the invention are characterized in dependent claims.

According to the invention, a stable quality grade for such data services is provided by virtue of the fact that, during the transmission of data packets which are associated with such a data service and are assigned to a quality class with the aim of possible preferential treatment, these data packets are possibly assigned to another quality class, which is expected to provide the quality grade demanded by the data service, on the basis of a result of a comparison between an acknowledged quality grade which actually exists in the packet-switching network and the demanded quality grade. In other words: the transmitter or at least one intermediate node in the packet-switching network establishes the quality of the transmission on the basis of acknowledgements which indicate the quality grade and compares the acknowledged quality grade with the quality grade demanded by the data service.

If the acknowledged quality grade is below the demanded quality grade, the transmitter or an intermediate node will assign the data packets associated with the data service to a higher quality class, of which the quality grade demanded by the data service is expected. If the acknowledged quality grade has virtually the same or a

higher value than the quality grade demanded by the data service, then the transmitter or the intermediate node possibly assigns the data packets associated with the data service to a low quality class, if the expectation of a constant quality grade is high. Otherwise, the quality class assigned at the start of data transmission is retained.

This means that, particularly at a high utilization level, the dynamic matching of the quality class on the basis of the network conditions prevents the quality grade from dropping during data transmission, and hence keeps the quality grade stable. In addition, the method according to the invention allows resource consumption in the packet-switching network to be controlled.

One development of the invention affords, in addition to the various quality classes, a plurality of priority classes within a quality class. Accordingly, the data packets associated with a data service are first assigned to another priority class within a quality class before they are assigned to another quality class. This provides an additional option for correcting the acknowledged quality grade to the quality grade demanded by the data service, without needing to change the quality class.

In accordance with one advantageous refinement of the invention, during a change to another quality class, the data packets associated with a data service are first assigned to the lowest priority class within the newly assigned quality class. This makes it possible to prevent the transmission of data packets assigned to the other quality class from being impaired as a result of the change.

Another refinement of the invention provides that, for the comparison between the acknowledged quality grade and the quality grade demanded by the data service, at least one upper

threshold value and at least one lower threshold value are introduced. Thus, if at least one upper threshold value is exceeded by the difference between the demanded quality grade and the acknowledged quality grade, this results in the data packets associated with the data service being assigned to a higher quality class or possibly to a higher priority class. If at least one lower threshold value is undershot by the difference between the demanded quality grade and the acknowledged quality grade, the data packets are assigned to a low quality class or possibly to a low priority class. This has the advantage of additional stabilization of the quality grade during data transmission owing to the fact that a constant change between the quality classes or the priority classes is avoided.

Another advantageous refinement of the invention uses not only the quality of the transmission of such data packets but also a further comparison parameter, namely the network utilization level. If the acknowledged quality grade and the quality grade demanded by the data service have virtually the same valve, the assignment of the data packets associated with the data service to a quality class is additionally dependent on the network utilization level. With a high network utilization level, the data packets are more readily assigned to a high quality class or possibly to a high priority class, and with a low network utilization level, these data packets are more readily assigned to a low quality class or possibly to a low priority class. The additional comparison parameter increases the likelihood of the quality grade which is to be expected being reached or at least retained when the quality class changes.

One development of the invention relates to an advantageous implementation with respect to the handling, on the basis of the associated quality class, of such data packets in an intermediate node. Before such data packets are

forwarded, they are temporarily stored in a queue which is based on their quality class.

In accordance with another refinement of the invention, the priority classes possibly available in a quality class are advantageously implemented such that the data packets arriving at an intermediate node and associated with a data service are temporarily stored in a queue before being forwarded and are characterized using a marker which is based on their priority class and can be used to discard the characterized data packets if the queue overflows.

An illustrative embodiment of the invention is described in more detail below with reference to a drawing.

The figure shows a packet-switching network to which the method according to the invention can be applied.

According to this, a subscriber terminal TLN is connected to the packet-switching network PN, e.g. the Internet, via an access node ZK. The indicated packet-switching network PN could likewise be a private packet-switching network, e.g. a company network. In the case of a private packet-switching network, the access node ZK is usually integrated into the subscriber terminal or into the private branch exchange. Such a private packet-switching network can also have a point of access to another private or public packet-switching network, e.g. to a company network or to the Internet. The packet-switching network PN in the figure can then be regarded as a communication network comprising all the private and public packet-switching networks.

The figure also shows a computer DK, e.g. of a service provider, which provides subscribers with data services, such as Video on Demand or Voice over IP, and is situated in the packet-switching network PN. The intermediate

nodes ZW1 to ZW4 connected in between the computer DK and the access node ZK in the figure indicate that there can be a plurality of connection options between the computer DK and the access node ZK. Thus, on the Internet, for example, as already mentioned in the introduction, it is customary for data packets to get to their destination independently of one another on different paths.

In the example, a subscriber uses his subscriber terminal TLN, e.g. a personal computer, to dial into the packet-switching network PN via the connection to the access node ZK, and uses an application program provided on his subscriber terminal to set up a connection to a computer DK, providing data services, of a service provider, e.g. via the intermediate nodes ZW1 to ZW4. The subscriber requests a video transmission service, for example, which requires a transmission bandwidth of 100 kbit/s. Accordingly, the data packets associated with the video transmission service are assigned to a mean quality class, for example, by setting a particular bit pattern in the 'TOS byte' of such a data packet. Assuming that there are quality classes of A (e.g. premium), B (e.g. normal) and C (e.g. best effort), with A distinguishing the highest class, then the data packets associated with the video transmission service are assigned to the class B in the example.

Ideally, the quality classes are subdivided further into priority classes, e.g. 1 (low) to 8 (high). By way of example, the data packets associated with the video transmission service are assigned to the priority class 4, with the priority class likewise being able to be characterized in the 'TOS byte' of such data packets.

At the start of transmission of the video transmission service, the data packets are thus sent with the quality class B and the priority class 4. During transmission, an intermediate node, e.g. ZW1, or the receiver, e.g. ZK or TLN, acknowledges to the

transmitter, in the example the computer of a service provider DK, the quality grade, such as the bandwidth, delay times to the network node and the packet loss rate for the transmission, using a protocol, e.g. the RTP/RTCP protocol mentioned in the introduction, and [lacuna] compares the acknowledged quality grade with the demanded quality grade. Expediently, at least one upper limit and at least one lower limit are stipulated for the comparison, and if said limits are exceeded or undershot by the difference between the demanded quality grade (NOMINAL value) and the acknowledged quality grade (ACTUAL value), for example for the transmission bandwidth, a change to another quality class or possibly priority class is triggered. In this case, the ACTUAL value can be determined, by way of example, by the average value with, if appropriate, a stipulated permissible discrepancy (e.g. +/- 5%) from quality grade values acknowledged cyclically over a particular period of time (e.g. 1 second). Accordingly, the levels for the difference between the NOMINAL value and the ACTUAL value can be set as triggers for a change to a higher/lower quality class or priority class such that, by way of example, the following rules are produced:

1. If a positive difference between NOMINAL and ACTUAL value has a value of more than 128 kbit/s, then a change to the highest quality class A is made.
2. A corresponding negative difference of less than -128 kbit/s triggers a change to the lowest quality class C.
3. With a positive difference of more than 64 kbit/s, there is a change to the next highest quality class.
4. With a corresponding negative difference of less than -64 kbit/s, there is a change to the next lowest quality class.
5. If the positive difference constitutes less than 64 kbit/s, or the negative difference constitutes more than -64 kbit/s, then the quality class is

retained.

6. A positive or negative difference of more than 8 kbit/s or less than -8 kbit/s results in a change to the next highest or lowest priority class (max. 8 priority classes).

Similar rules can likewise be stipulated for other quality grade features than for the transmission bandwidth, such as for the delay time, the packet loss rate and the throughput. Particularly with a voice data service such as Voice over IP, the transmission bandwidth would be less of a crucial factor for a change of quality class than the delay time and possibly the packet loss rate.

By way of example, a transmission bandwidth of 76 kbit/s obtained at the receiver, e.g. TLN, is acknowledged to the transmitter, e.g. DK, instead of the demanded transmission bandwidth of 100 kbit/s. The transmitter then rearranges the data packets associated with the video transmission service from the priority class 4 into the priority class 5, for example on the basis of the rules 5 and 6 indicated above. If the transmission bandwidth of 100 kbit/s is now detected, the priority class can be retained. Otherwise, reassignment to a higher priority class is repeated until the demanded transmission bandwidth is reached. Under the circumstance in which the highest priority class in the quality class has already been assigned and only a transmission bandwidth of, by way of example, 85 kbit/s could be achieved, it is appropriate to assign the data packets associated with the video transmission service to the next highest quality class, e.g. A. Expediently, these data packets in the next highest quality class are then first assigned to the lowest priority class, e.g. 1, so as not to impair the quality of the transmission of data packets associated with other data services within this quality class. If the influence on the transmission quality is too great, the data packets associated with the video transmission service can, if appropriate, be removed from this

quality

class and assigned to the original quality class again.

Advantageously, the network utilization level can also be used to determine the quality or priority class. Thus, in addition to the transmission bandwidth obtained at the receiver, the delay times or fluctuations in the delays can also be acknowledged. Accordingly, after repeated assignment to a higher priority class and with a subsequently acknowledged short delay time, it would be possible to try to assign the data packets associated with the video transmission service to a lower priority class or possibly to a lower quality class again. In the case of a long delay time, which indicates a high network utilization level, the data packets associated with the video transmission service are more readily assigned to even higher priority classes or are predominantly assigned to a higher quality class. In addition, the data packets associated with other data services in the packet-switching network could be prevented from changing to a higher priority class or quality class.

Expediently, the quality classes are implemented in the form of separate queues in the network nodes (intermediate nodes, e.g. ZW1 to ZW4) of the packet-switching network. The data packets arriving at the intermediate nodes are temporarily stored in a queue which is based on their quality class before being forwarded. The priority classes are usefully produced by a 'drop level' mechanism. That is to say that the data packets arriving at an intermediate node are provided with a marker which is based on their priority class and are temporarily stored in a queue which is based on their quality class. If the queue overflows, the data packets associated with a low priority class are discarded first.

Patent claims

1. A method for providing a stable quality grade for data services within a packet-switching network (PN) which has at least one access node (ZK) for connecting at least one subscriber terminal (TLN) and/or at least one private branch exchange having at least one connected subscriber terminal, and of whose network nodes at least one network node (DK) provides data services, the data packets associated with a data service being assigned, at the start of their transmission between a network node (DK) providing such data services and a subscriber terminal or an access node connected directly or indirectly to a subscriber terminal, to a quality class on the basis of which the data packets are handled within the intermediate nodes (ZW1,...,ZW4) which forward the data packets, characterized
in that, during the transmission of such data packets, the transmitter (DK) and/or at least one intermediate node (ZW1,...,ZW4) establishes the quality of the transmission on the basis of acknowledgements indicating the quality grade and compares it with the quality grade demanded by the data service, and in that, depending on the result of the comparison, the data packets associated with the data service are possibly assigned to another quality class, of which the quality grade demanded by the data service is expected.

2. The method as claimed in claim 1, characterized in that a quality class has a plurality of subordinate priority classes, and in that the data packets associated with a data service are first assigned to another priority class within a quality class before assignment to another quality class takes place.

3. The method as claimed in claim 2, characterized in that if the data packets associated with the data service are

assigned to another quality class, the data packets are first assigned to the lowest priority class.

4. The method as claimed in one of the preceding claims, characterized in that at least one upper and at least one lower threshold value can be stipulated for the comparison between the acknowledged quality grade and the quality grade demanded by the data service and, if at least one upper threshold value is exceeded by the difference between the demanded quality grade and the acknowledged quality grade, the data packets associated with the data service are assigned to a higher quality class or possibly to a higher priority class, and, if at least one lower threshold value is undershot by the difference between the demanded quality grade and the acknowledged quality grade, the data packets are assigned to a low quality class or possibly to a low priority class.

5. The method as claimed in one of the preceding claims, characterized in that, besides the quality of the transmission of such data packets, the network utilization level is also acknowledged, and, if the acknowledged quality grade and the quality grade demanded by the data service have virtually the same value and the network utilization level is high, the data packets are more readily assigned to a high quality class or possibly to a high priority class, and, if their value is virtually the same and the network utilization level is low, the data packets are more readily assigned to a low quality class or possibly to a low priority class.

6. The method as claimed in one of the preceding claims, characterized in that the data packets arriving at an intermediate node (ZW1,...,ZW4) and associated with a data service are temporarily stored in a queue which is based on their quality class before they are forwarded.

7. The method as claimed in one of claims 2 to 6, characterized in that the data packets arriving at an intermediate node (ZW1,...,ZW4) and associated with a data service are temporarily stored in a queue before being forwarded and are characterized using a marker which is based on their priority class and can be used to discard the characterized data packets if the queue overflows.

GR 98 P 5926

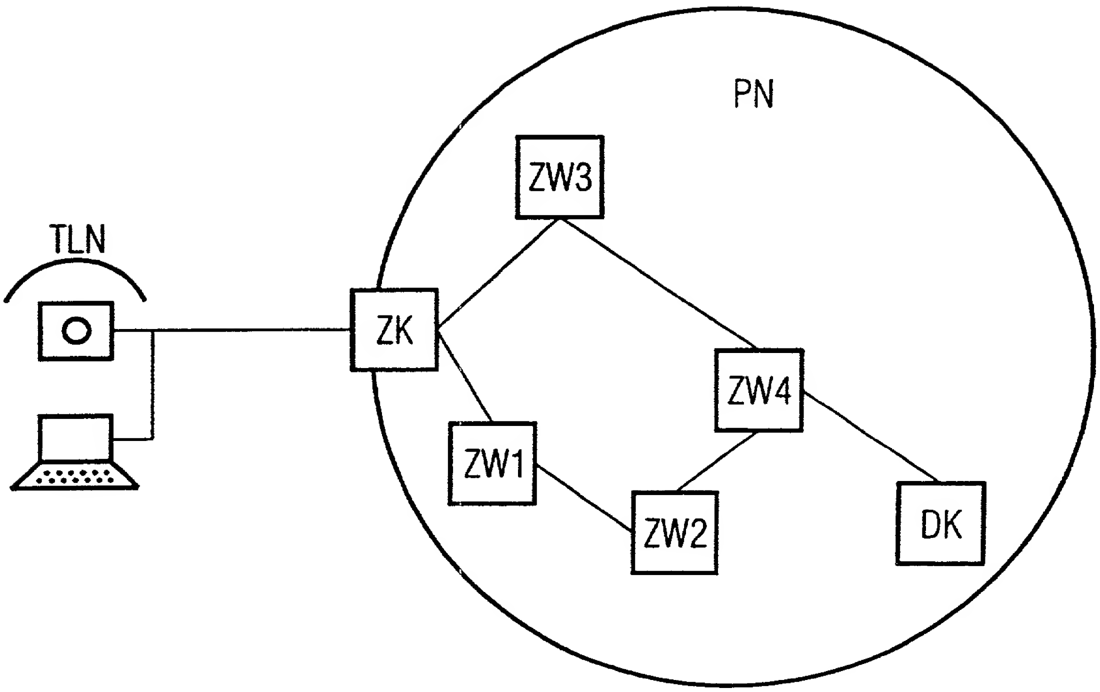
Abstract

Method for providing a stable quality grade for data services within a packet-switching network

In a packet-switching network (PN), a stable quality grade is achieved for data services by virtue of the fact that, during the transmission of data packets which are associated with a data service and are assigned to a quality class for the purposes of possible preferential treatment, the transmitter, generally a computer of a service provider (DK), and/or at least one intermediate node (ZW1 to ZW4) establishes the quality of the transmission on the basis of acknowledgements indicating the quality grade and compares it with the quality grade demanded by the data service, and, on the basis of the result of the comparison, the data packets associated with the data service are possibly assigned to another quality class, of which the quality grade demanded by the data service is expected.

Figure

09/868086



Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

As a below named inventor, I hereby declare that:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

My residence, post office address and citizenship are as stated below next to my name,

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Verfahren zur Bereitstellung einer stabilen Qualitätsgüte für Datendienste innerhalb eines paketvermittelnden Netzes

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

____

deren Beschreibung

(zutreffendes ankreuzen)

☒ hier beigefügt ist.

☒ am 01.12.1999 als PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/DE99/03851
eingereicht wurde und am __________
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the specification of which

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PCT Application No. __________
and was amended on __________
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Ich bestätige hiermit, dass ich den Inhalt der obige□n Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

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Prior foreign appplications
Priorität beansprucht

Priority Claimed

198 57 822.9	Germany	15. Dezember 1998	[X] Yes / Ja	[ ] No / Nein
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)		
			[ ] Yes / Ja	[ ] No / Nein
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)		
			[ ] Yes / Ja	[ ] No / Nein
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)		

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(Application Serial No.) (Anmeldeseriennummer)	(Filing Date) (Anmeldedatum)	(Status) (patentiert, anhängig, aufgegeben)	(Status) (patented, pending, abandoned)
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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

And I hereby appoint

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Wohnsitz	Residence
Staatsangehorigkeit	Citizenship
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(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).